

LISTING OF CLAIMS

This listing of the claims will replace all prior listings:

1. (Currently Amended) A frequency beamsplitter for use in the frequency basis, to receive wherein a pair of input photons are and produce separated output photons separated in frequency space by radio or microwave frequencies, the frequency beamsplitter comprising: an asymmetric two-path interferometer, reversible down to the quantum limit, arranged with a first partially transmitting mirror to split input photons into first and second paths, a time delay element to introduce a differential time delay into the second path such that a pair of input photons are separated, by the time delay element, in the frequency space by the radio or microwave frequencies, and a second partially transmitting mirror to mix the two paths again to form two outputs respectively delivering photons at different frequencies separated in the frequency space by a radio or microwave frequency determined by the time delay.

2. (Original) A frequency beamsplitter according to claim 1, wherein the interferometer has a frequency dependent phase shift.

3. (Original) A frequency beamsplitter according to claim 2, wherein the interferometer is a Mach-Zehnder interferometer.

4. (Withdrawn) A frequency beamsplitter according to claim 2, wherein the interferometer is a Michelson interferometer.

5. (Currently Amended) A frequency beamsplitter according to claim 1, wherein, additional mirrors are provided between the partially transmitting mirrors or at the output to redirect the first and second paths to provide the two outputs at convenient locations.

6. (Previously Presented) A frequency beamsplitter according to claim 1, comprising mirrors and a time delay implemented using optical fibre structures.

7. (Previously Presented) A frequency beamsplitter according to claim 1, comprising mirrors and a time delay implemented using planar waveguide structures.

8. (Previously Presented) A frequency beamsplitter according to claim 1, arranged to operate with single photons.

9. (Currently Amended) A radio frequency half-wave for use in the frequency basis, comprising a frequency beamsplitter according to claim 1, wherein the frequency beamsplitter is a first frequency beamsplitter and operates in a first direction to split a beam of photonic qubits encoded in different frequency modes, an acousto-optic modulator driven to receive the outputs from the first frequency beamsplitter and couple of the two different frequency and spatial modes of the outputs together via a phonon interaction to produce two further outputs, and provide the two further outputs to a second frequency beamsplitter, wherein the second frequency beamsplitter operates in a direction reverse to the first direction and produces according to claim 1, operating in reverse to receive the two further outputs from the acousto-optic modulator and produce a combined output.

10. (Currently Amended) A radio frequency half-wave plate according to claim 9, wherein ~~the second a single~~ frequency beamsplitter is physically discrete from the first frequency beamsplitter used, operating in one direction and in reverse.

11. (New) A radio frequency half-wave plate according to claim 9, wherein the second frequency beamsplitter and the first frequency beamsplitter are a single device capable of operating in both the first direction and the reverse direction, with the single device serving as the first frequency beamsplitter when operating in the first direction and as the second frequency beamsplitter when operating in the reverse direction.